Claims

1. Membrane-electrode assembly for the electrolysis of water, comprising

   - an ion-conducting membrane having a front side and a rear side (1)
   - a first catalyst layer on the front side (2)
   - a first gas diffusion layer on the front side (4)
   - a second catalyst layer on the rear side (3)
   - a second gas diffusion layer on the rear side (5)

   wherein the first gas diffusion layer (4) has smaller planar dimensions than the ion-conducting membrane (1) and the second gas diffusion layer (5) has essentially the same planar dimensions as the ion-conducting membrane (1).

2. Membrane-electrode assembly according to Claim 1, wherein the catalyst layer on the front side (2) and the catalyst layer on the rear side (3) of the ion-conducting membrane (1) have different planar dimensions.

3. Membrane-electrode assembly according to Claim 1 or 2, wherein the ion-conducting membrane (1) has a free surface (6) which is not supported by a gas diffusion layer on the front side.

4. Membrane-electrode assembly according to any of Claims 1 to 3, wherein the catalyst layers on the front side (2) and on the rear side (3) comprise catalysts comprising precious metals and optionally ion-conducting materials.

5. Membrane-electrode assembly according to any of Claims 1 to 4, wherein the margin of the gas diffusion layers (4, 5) and the free surface (6) of the ion-conducting membrane (1) which is not supported by a gas diffusion layer are surrounded by a sealing material (7).

6. Membrane-electrode assembly according to any of Claims 1 to 5, wherein the gas diffusion layer on the front side (4) comprises carbon-based materials such as graphitized or carbonized carbon fibre paper, carbon fibre nonwoven, woven carbon fibre fabric and/or similar materials, while the gas diffusion layer on the rear side (5) comprises non-carbon based materials, for example woven metal meshes, metal nonwovens, gauzes, metal staple fibres, metal multifilaments and/or other porous metallic structures.

7. Membrane-electrode assembly for the electrolysis of water, comprising

- an ion-conducting membrane having a front side and a rear side (1)
- a first catalyst layer on the front side (2)
- a first gas diffusion layer on the front side (4)
- a second catalyst layer on the rear side (3)

wherein the ion-conducting membrane (1) has a free surface (6) which is not supported by a gas diffusion layer on the front side.

8. Membrane-electrode assembly according to Claim 7, wherein the catalyst layer on the front side (2) and the catalyst layer on the rear side (3) of the ion-conducting membrane (1) have different planar

dimensions and comprise catalysts comprising precious metals and optionally ion-conducting materials.

9. Membrane-electrode assembly according to Claim 7 or 8, wherein the margin of the gas diffusion layer (4) and the free surface (6) which is not supported by a gas diffusion layer on the front side of the ion-conducting membrane (1) are surrounded by a sealing material (7).

10. Membrane-electrode assembly according to any of Claims 1 to 9, wherein the ion-conducting membrane comprises organic polymers such as proton-conducting perfluorinated polymeric sulphonic acid compounds, doped polybenzimidazoles, polyether ketones, polysulphones or ion-conducting ceramic materials and has a thickness of from 10 to 200 µm.

11. Membrane-electrode assembly according to any of Claims 1 to 10, wherein the second catalyst layer on the rear side (3) comprises catalysts containing precious metals for the anodic evolution of oxygen, preferably catalysts based on iridium and/or ruthenium.

12. Membrane-electrode assembly according to any of Claims 1 to 11, wherein the sealing material (7) comprises thermoplastic polymers from the group consisting of polyethylene, polypropylene, polytetrafluoroethylene, PVDF, EPDM, polyester, polyamide, polyamide elastomers, polyimide, polyurethane, silicones, silicone elastomers, etc., and/or thermoset polymers from the group consisting of epoxides and cyanoacrylates.

13. Process for producing the membrane-electrode assembly according to any of Claims 1 to 12, which comprises the steps:

(a) coating of an ionomer membrane (1) with catalyst on one side,

(b) coating of a carbon-based gas diffusion layer (4) with catalyst on one side,

(c) joining of the carbon-based, catalyst-coated gas diffusion layer (4) to the uncoated side of the ionomer membrane (1), with the catalyst layer (2) coming into contact with the ionomer membrane (1),

(d) optionally, application of a non-carbon based gas diffusion layer (5) to the rear side, with the catalyst layer (3) on the ionomer membrane (1) coming into contact with the gas diffusion layer (5),

(e) application of a sealing material (7) in the peripheral region of the membrane-electrode assembly.

14. Process according to Claim 13, wherein the joining of the carbon-based, catalyst-coated gas diffusion layer (4) to the uncoated side of the ionomer membrane (1) is carried out at elevated temperature and/or elevated pressure.

15. Process according to Claim 13 or 14, wherein the application of the sealing material (7) is effected by means of melting processes, injection moulding, heat pulse welding and/or hot pressing.

16. Use of the membrane-electrode assembly according to Claim 1 in electrolysers, regenerative fuel cells, oxygen-producing electrodes or other electrochemical devices.